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CONTENTS

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SCIENCE AND PUBLIC SERVICE[1]

THE educational ideals of a people reflect in no small degree the social, political and industrial conditions of that people and of the nation of which they form a part. This is but natural. Those ideals of education that have prevailed in the past have stood in close relation to the general progress and development of civilization, and such ideals have always been, and must always continue to be, in conformity with those vital forces that dominate a nation's life and activity, as expressed in its art, its religion, its social and industrial conditions, and its form of government.

No more striking illustrations of this can be had than in the histories of Greece and Rome. The educational ideals of Greece found their source and inspiration in that emotional nature which worships the beautiful in both thought and action, and which finds its highest form of expression in literature, art and philosophy—the very essence of Grecian culture. The Roman ideals, on the other hand, were characterized by that rugged element of human strength which emphasizes the practical and reverences the useful. It trained men to frame laws, lead armies, construct aqueducts and public highways, and made possible that military success and judicial power which have not only commanded the admiration of all times, but have contributed to the general advance of civilization by becoming the bearer of eastern culture to the very confines of Europe. Again, when in the middle ages the church

[1] An address before the summer session of the University of Illinois Biological Station, July 22, 1910.

dominated both state and social institutions, quite different educational forces came into prominence.

As we now see, all of these educational motives were narrow and incomplete, and failed in the highest purposes of an education in that they each afforded an opportunity to develop strongly the ability of the individual in but a single direction. It was not until they became united, enriched and ennobled by that independence of thought and that Christian democracy which were the outgrowth of the protestant reformation that we find the dawn of that higher type of educational thought and activity which characterizes our modern institutions of learning.

Whatever may be our estimate of this or that system of education, or of this or that branch of study, we shall all agree that that education is best which best trains the individual to meet the demands of organized society as it exists and enables him to contribute most to the general welfare and advancement of the community and of the nation of which he is a member. Such a standard may and certainly does vary with the community and with the nation. Moreover, the educational ideals of any progressive people are bound to change with the development of national resources and national character and with the general progress of civilization. The instruction now offered by the great universities of Europe is quite different from that given by the same institutions a century or more ago. The same is true in our own country. Those who have followed even casually our educational history know how very different is the curriculum of such institutions as Harvard to-day as compared with that presented by the same institution during the early years of its existence. The prominence once occupied by Hebrew, Assyrian and Sanskrit has now given place to the study of modern languages and literature; the Greek and Latin requirements have been greatly reduced, and instead history and the social sciences have come to be recognized as important elements of a liberal education. The natural sciences, once represented at Harvard by a brief course in natural philosophy, astronomy, and half an hour a week devoted to botany during the spring months, have gradually been expanded until there is now offered sufficient work in these branches at this institution alone to require the entire time of a student for a dozen years to complete it.

Moreover, the fully equipped modern American university is no longer the traditional college of liberal arts of England, nor is it confined to the four faculties of the continental institutions. We have in addition to these in most of our institutions strong technical departments giving instruction in the various branches of agriculture and engineering.

In technical education America leads the world. Not only was shop-practise, as the laboratory of the engineer, first introduced in this country, but several of the best European technical laboratories have been patterned after those of a leading American institution. This is what we might reasonably have expected. The American people have been and still are busily engaged in the conquest of a continent. Its resources are vast and varied and their development presents a wide range of industrial problems, the solution of which have had, as they should, no small influence upon the character and the trend of our educational institutions. To meet the demand for trained men in the industries, strong engineering schools have sprung up in most of our great centers of population and the states themselves have recognized their obligation and their opportunity by establishing technical schools in connection with their state colleges and universities.

Another condition that is bound to influ-

ence in no small degree the trend of our educational institutions is the fact that our population is rapidly increasing and that the public domain now at our disposal for future expansion is practically exhausted. It is significant in this connection to observe that within the last one hundred years, we have four times doubled our population, and it is a conservative estimation that within the next century we shall be obliged to maintain a population of more than five hundred million people. Should our population ever reach the present density of that of England, for example, a state no larger than Illinois would have within its borders approximately as many people as were living in the entire United States at the beginning of the civil war. With this increased density of population, there are bound to come new and important problems, which it is the part of good educational statesmanship to anticipate.

Certainly one of the most fundamental of these problems is the question of food and the maintenance of the fertility of our soil sufficiently to insure a permanent agriculture. The American people have wisely foreseen that to meet this condition of continued prosperity scientific instruction in agriculture is necessary, and in most of the states magnificent provisions have been made for it and most excellent results have already been obtained.

It is a matter of profound congratulation that our philanthropists and our law makers have exhibited such keen foresight in making ample provision for these important phases of our national development. It is, however, a cause for still more profound congratulation that while providing for these fields of our educational activity, there has been no disposition to sacrifice the opportunity for educational advantages in other lines, including the time-honored liberal professions of law and medicine.

In America, at least, we have come to accept as a fundamental principle that the supreme test of an education is the efficiency of the training it gives the individual to meet the demands of organized society, and at the same time enable him to contribute most either directly or indirectly to the general progress of national life. With our changing conditions in mind, we may well study, therefore, somewhat more closely the general trend of our educational ideals, to the end that we may the better judge what more, if anything, can be done to more fully prepare the coming generation better to meet the demands of the future and to discover, if possible, some of those things which our educational institutions should undertake in a broad and comprehensive manner if they are to promote our national interests to the highest degree and enable America to contribute its full share to the world's progress.

The most potent influence in recent educational movements, the dominant factor which more than any other has led us to modify both the content of our college curricula and our methods of instruction, has been the growing importance of the sciences and the development of the scientific spirit. It has been of fundamental importance in the marvelous strides which we have made in both industrial and technical education and is bound to be still more significant in the continued development of our educational activity in these lines. Significant, however, as has been our indebtedness to the sciences in the affairs of everyday life and in technical education, still more important, from an educational point of view, is the influence which the scientific spirit has exerted upon educational progress in general and in particular upon the character of the work usually accepted for a liberal academic degree. The

popular conception of a liberal education is no longer confined exclusively to the humanities. All are now agreed that the study of the natural sciences affords a training and a discipline quite as worthy of recognition toward the A.B. degree as that afforded by the study of language, philosophy, and mathematics. Moreover, no one can longer lay claim to a liberal education who has not by formal and serious study made himself familiar in a broad and comprehensive way with the fundamental principles of the biological and physical sciences. I hope that no one will understand me as belittling in the least the value and importance of literary studies. These branches of study are essential to the training of any individual, but they present but one side of that training which the world is now pleased to call a liberal education. History, which opens up to us the accumulated treasures of the centuries; economics and the social sciences, which show us the relation of man to man and to organized society; language and literature, which reveal to us the thought and the masterpieces of other tongues and of other peoples, are all essential elements of a liberal education, but none the more so than are the facts and phenomena which show the relation of man to the animate life with which he is surrounded, or to the laws of the inanimate world with which he must deal in every-day life. All of these elements are necessary in the training of any man who would longer lay claim to a liberal education in any significant sense of that term.

When in 1824 there was established a physiological laboratory at Breslau and in the following year Liebig opened at Giessen his chemical laboratory fully equipped for the use of students and investigators, there was introduced into education a new and very important influence. Stimulated by these centers of scientific activity and by the laboratories of Berzelius in Sweden and Gay-Lussac in Paris, the necessity of laboratory instruction spread with great rapidity to the sciences in general until to-day the laboratory as an educational factor, has come to take its place alongside the library as the two most important features in the equipment of a modern educational institution. The introduction of the laboratory and of laboratory methods of dealing with problems of research has introduced in all fields of human thought an entirely new method of attacking problems of investigation. Formerly, when a scholar wished to investigate a subject, he merely sat down and philosophically meditated concerning it. As a mental performance it was not altogether without value, but scientifically the results were not unfrequently of little or no consequence. To-day, due to that scientific spirit which has come to pervade all investigation, the process is quite different. The first business of the investigator now is to determine all the facts relating to the question under consideration and then by a study of those facts to deduce general laws. We must not, however, make the mistake of assuming that the influence of the scientific spirit has been confined alone to the branches of science. It has spread to the study of the humanities themselves; and we have a good deal to say now-a-days about the scientific method of studying history, economics and philology. Indeed, so far has this method been applied to subjects other than the natural sciences, that those branches of study which have to deal with the relations of man to man, both past and present, including therefore economics, sociology and history, are often spoken of as "the social sciences."

I have said enough perhaps to show the importance and wide-spread influence of scientific study so far as it has come to be

a necessary and essential element in the training of a man to best meet the demands of our times and social conditions. It is not sufficient, however, that our educational institutions should provide merely for instruction in the sciences. I wish especially to emphasize the importance of making every provision for scientific research on the part of both students and faculty. Every educational institution, whether supported by public tax or by private endowment, should stand for scientific investigation. It is of fundamental importance not only to that continued growth of both industrial training and technical education so necessary to fit men to direct us in the development and economic use of national resources, but such work is equally important and necessary in the proper training of men who shall direct us in the methods of correct living, who shall tell us how to prevent as well as how to cure disease, and who shall become the guardians of public sanitation and of public health. The substantial basis for continued progress in these lines is the provision we make for research in the physical and biological sciences.

The establishment of great laboratories for the purposes of research has been one of the chief contributions of the last century. Previous to the nineteenth century, the great inventions were brought about not so much as a result of any special scientific training as by mere accident or the practical requirements of the age. During the past fifty years the case has been quite different. The great discoveries have been made in scientific laboratories and as the result of unusual insight acquired by special investigation. As one of our writers has recently put it, "Formerly, *necessity* was the mother of invention, latterly, the tables have been turned and scientific discoveries have produced new practical needs and *created* spheres of labor, industry and commerce."

We are too apt to forget the contribution that research in pure science has made to the general progress of the industries and of the scientific professions. We need to be reminded now and then that the marvelously successful applications of science which have in recent years revolutionized to such an extent our industrial and professional life, have usually been preceded by equally brilliant scientific *research,* although this has been less in the lime light of public admiration. For example, some fifty years ago the scientific world had its attention called for the first time to the significance of the coal-tar products. The initial discovery that directed the attention of scientists to this fruitful field of research was made by a young and then unknown chemist of London. With the use of such time as he could spare from his routine duties as assistant to Professor Hofman, and with an equipment by no means equal to that of our modern laboratories, this brilliant young scientist made a discovery which has since revolutionized several of our leading industries and has influenced nearly every branch of activity. Through the wide range of the applications of these coal-tar products, we have now come to a fuller appreciation of the genius of this young scientist—since known as the distinguished Sir William Henry Perkin. It was a marvelous series of investigations, which have since enabled the commercial world to produce nearly if not quite 2,000 distinct dyestuffs, giving the entire range of color known to man. Not only are they used in coloring fabrics of all kinds, but leather, woods, paper, bones, ivory, feathers, straw and grasses are so changed in hue by means of these dyes as to meet every demand of taste or fashion; and while in beauty and brilliancy they produce

effects surpassing those supplied by nature, they are also in many cases less affected by time and light.

Nor is this all, for from this offensive pot of tar—once a troublesome by-product in the manufacture of coke and gas—not only are the fabrics which we wear and the decorations of our homes made more attractive to us in color, but from the same source there are produced to-day the delicate fragrance of the rose and the violet, as well as the most popular of our flavoring extracts. In the reproductive arts, in photography, in the preservation of foodstuffs, and even in medicine the results have been quite as startling and wonderful. The scientific discovery that has made all of this possible attracted little attention at the time, and doubtless would never have become generally known had it not been for the generous financial support accorded Perkin by his father in putting his results upon a commercial basis. However, its great economic and industrial importance can now be realized when we are told that from one of the 2,000 dyestuffs now manufactured because of it, there has been in a single year a saving to the industrial world of as much as $20,000,000—a sum approximately equal to the endowment of the universities of Harvard or Columbia, and nearly three times that of Yale or Cornell. This wide range of applications could not have been anticipated, but so important and valuable have these products become commercially that by-product ovens recently introduced in the manufacture of coke and gas have made the former by-products the principal sources of revenue.

No less remarkable in their contributions to the permanent good of mankind and no less brilliant as scientific investigations are the famous researches and discoveries of Pasteur. The work which has made his name a familiar one in every country and at every fireside in the civilized world, was not a scientific accident, but the culmination of a lifetime spent in research which had already yielded results of the highest scientific and industrial importance. His revelation of the existence of bacterial organisms in the world about us and his demonstration of the relation of these microscopic organisms to the process of fermentation and putrefaction, had enabled Lister years before, in fact even before investigation had shown the causative agency of bacteria to disease, to make one of the first and most important applications of bacteriology to the prevention of disease by the introduction of antiseptic surgery, a result which has enabled the medical profession to save the lives of countless thousands.

Koch received his early training and inspiration from the investigations carried on under the direction of Professor Cohn in his botanical laboratory at Breslau, and his subsequent researches upon the cholera germ, at the Berlin Institute and his even more important work that resulted in the discovery of the causative bacillus of tuberculosis and the development of tuberculin are too well known to you and their importance in preventing the spread of these dread diseases is too well appreciated to call for further comment.

The investigations of Metchnikoff, the distinguished Russian zoologist and embryologist, certainly place him among those who have accomplished most in the bearing of the biological sciences upon the prevention of infectious diseases. For eighteen years after graduation he was for the most part engaged in embryological and zoological investigation and discovered many important facts now commonly known to scientists in those fields. In these researches he came in contact with the wonderful activity and efficiency of the white corpuscles of the blood in combating disease

germs. As a result of his research we have his doctrine of phagocytosis, which is the basis of the now generally accepted theory of immunity from disease that has enabled us to do so much to reduce the danger of infection from disease.

All will recall the valuable work of Major Ross, of the Indian Army Medical Staff, in demonstrating by patient and persevering experiment the relation of the malaria parasite to a particular species of mosquito; and the investigation of our own Major Reed and his colleagues of the Cuban Commission in connection with yellow fever. The results of both investigations are common knowledge and have done much in making inhabitable by the white man the vast tropical regions of the earth. It is well, however, for us to remember that these brilliant discoveries had been preceded and made possible only by the long and patient scientific study of the mosquito as such, without any thought that the facts obtained by such research should ever have any significance in controlling or eradicating a dangerous disease. As one writer of prominence in the scientific world has put it:

> The biologist has thus come into closer touch than ever with the profession of medicine, and the time has arrived when the professional students of disease admit that they must bring to their great and hopeful task of abolishing the diseases of man the fullest aid from every branch of biological science. I need not say how great is the contentment of those who have long worked at apparently useless branches of science, in the belief that all knowledge is good, to find that the science that they have cultivated has become suddenly and urgently of the highest practical value.

The contributions of scientific research, in recent years, to the general progress of civilization have been indeed noteworthy, and no less gratifying has been the service rendered by science in the development of our national resources and in the growth and the expansion of our industrial and commercial enterprises. There is at this time, however, in response to an awakened public interest, another and equally important development of scientific activity demanding our serious consideration. I have reference to the relation of the sciences to questions of public health and preventive medicine, and it is to this aspect of our educational activity that I wish to direct your attention so far as I may in the time at our disposal.

In these times when we are discussing with great enthusiasm the conservation of our national resources and attempting to insure our continued prosperity by anticipating the problems that will confront us when we shall have become a nation of half a billion people, we are bound to recognize the fact that after all one of the greatest resources of this or any other nation is the preservation and protection of the health of its people. As our former president, Mr. Roosevelt, said in one of his messages to Congress:

> This problem is but a part of another and greater problem to which we as a nation are not yet fully awake, and with which we must grapple in the great contest of nations—*the problem of national efficiency.*

It is but natural that the American people, busy as they have been in the conquest of a continent, should have disregarded somewhat the problems of sanitation and public health to consider first those interests which have developed our industrial life and established our commercial standing. The time has forever passed, however, when a man may be regarded as fulfilling his entire duty when he protects the members of his immediate family from the inroads of disease. It has become a matter of public concern as to how far we shall allow our families or our community to be exposed, through the ignorance or carelessness of others, to infec-

tious diseases or to contaminated and adulterated food supplies. We do not as yet fully realize the value of human life as a public asset. To estimate the financial value of a human life to the community is no more difficult as a mathematical problem than to compute an insurance premium or to adjust a loss from fire. Judged from the standards set by the decisions of the courts of our country, reflecting as they do in a way the opinion of the American people as to the value of human life, it is conservative to say that the state of Illinois, for example, lost during 1907 more than $1,500,000 by deaths from typhoid fever alone, a disease which, as we all know, is due largely, if not wholly, to a neglect of the proper laws of sanitation. Every death from a preventable disease appears upon the debit side in the trial balance of a community or of a nation. Commissioner Evans, of Chicago, estimates that 45 per cent. of the deaths last year in that city were caused by preventable diseases. It is now nearly half a century since the strife between the north and the south culminated in that memorable and bloody conflict known as the civil war. Nearly every hearth-stone tells the sad story of a broken family circle and the nation still mourns the long list of her heroic dead. Tremendous as was the loss of life in those eventful four years, it is a significant fact to be observed in this connection that 25 per cent. more deaths occur every year in this country from tuberculosis than the total loss of all of the union forces in battle and from wounds during the entire four years of the civil war. Unless this disease is checked, it is said that there are 5,000,000 of people now living in the United States who are destined to a premature death from this one cause. It is difficult for us to realize the enormous loss to the wealth of the country which this involves. A most careful study of this aspect of the question has been made by Professor Glover, of the University of Michigan. He has shown upon what would seem to all of us, I am sure, a very conservative estimate of the earning capacity of the individual during the working years of his life, that the annual financial loss to the United States is more than $36,000,000 —nearly twice the total bi-ennial income of the state of Illinois. In other words, the United States could well afford to spend $36,000,000 each year if thereby this disease could be brought under the same control as are other preventable diseases.

Much has been accomplished and more is now being undertaken in the control of diseases by our state and municipal boards of health. However, their efforts are directed for the most part to applying known results and methods to preventing the spread of diseases rather than to the serious study of the *scientific problems* arising from unhealthful conditions. Much is also being accomplished by the scientific departments of our educational institutions, but the provision for scientific research in these lines is altogether inadequate for future needs and for the magnitude of the opportunity at hand. We are not doing for the public and private health of our people anything like what we are doing for the development of our commercial and industrial interests. We have in all our states and territories agricultural experiment stations, some sixty in all, the main function of which is the investigation of questions relating to the promotion and preservation of our national agricultural interests. A magnificent and important work is being accomplished at a public expense of millions of dollars annually, employing for this purpose more than a thousand people. There is no doubt in the mind of any public spirited man or

woman that it pays to make this expenditure for the promotion of interests so important. A bill was introduced in the last congress asking that similar provision be made in each state for an engineering experiment station which should undertake the scientific study of those problems which are fundamental to the material and industrial development of our country. All are glad to see these provisions made, for we all not only have a pride in the industrial and commercial prosperity of the country, but we are all directly or indirectly connected with it and depend upon it.

Why should we not do as much, however, to promote the conditions for healthful living among our people as to stimulate the development of our national resources? But few of us are agriculturists, and not all are directly concerned in the prosecution of industrial enterprises needing the assistance of a trained engineer, but every one of us, irrespective of vocation, is vitally concerned with those scientific facts that mean better sanitation, better facilities for overcoming and preventing the spread of infectious diseases, in short, with all that knowledge which will enable us to live better, longer and happier.

Until within the last ten years there was not a single institute for medical research in America, although France, Germany Russia and even Japan had such institutions. These institutions and others of a similar character have rendered an important and valuable service to medical science and to mankind. Since the opening of Pasteur Institute, for example, in 1888, more than 25,000 people have been treated for hydrophobia at the Paris Institute alone, to say nothing of the thousands who have been saved from the terrible consequence of this disease the world over by the methods perfected by Pasteur. To have cured such an army of human beings is enough honor for any institution and sufficient cause for its foundation. The influence of the institute however has not ended here. It is essentially a school of bacteriology where the student and the investigator are given instruction and afforded an opportunity to extend both his personal knowledge and that of the world in the application of science to the cause and prevention of disease. It was here that Calmette, the discoverer of serum treatment for serpent-poisoning, and Yersin, whose famous researches in the prevention and cure of cholera are known to all, received their training. The institute has always had associated with it some of the best scientific investigators of the world. Here Roux did the work which will forever connect his name with the serum treatment of diphtheria, and Chamberland has directed the work in economic bacteriology in its applications to hygiene, including the development of serum for the various diseases of domestic animals by which it is said that a million sheep and half that many cattle are annually given immunity from anthrax. Here also Metchnikoff has carried on his investigations which have done so much to improve human conditions by immunity from disease.

The record of achievements at the Pasteur Institute is typical of those of the Berlin Institute of Hygiene and others which have been founded for similar purposes. There is no need to multiply illustrations. All are familiar with the results and know something of the work of the large number of brilliant investigators who have thus been enabled to give their time and attention to this fruitful field of research.

Within the last ten years substantial progress has been made in America in pro-

viding for scientific research along lines which have a direct bearing upon the practise of medicine. We now have among others the Rockefeller Institute for Medical Research in New York with its endowment of $3,000,000;[2] the Laboratory for the Investigation of Cancer at Buffalo, supported by the state of New York; the Phipps Institute for the Study of Tuberculosis at Philadelphia, and the Institute for Investigation of Infectious Diseases, endowed by Mr. and Mrs. McCormack, of Chicago. No more commendable or fruitful field for the philanthropist can be found in any sphere of educational activity than in providing the financial support needed for such institutions. I can see no reason, however, why we should leave such an important field of inquiry wholly to the generosity of public-spirited men and women. Legislative bodies are becoming interested and are willing to provide means for the study and control of preventable diseases. Twenty-eight of the forty-three state and territorial legislatures in session two years ago passed laws concerning tuberculosis, and ten states have recently made appropriations amounting in the aggregate to $100,000 to be used exclusively in the education of the public concerning this disease. Much has been done and is now being accomplished by the scientific bureaus at Washington. The Bureau of Chemistry, through the pure food and drug act, the Marine Hospital Service, and others are devoting much attention to the problem of protecting the health of the public. In April President Taft sent a message to congress recommending an appropriation of $50,000 for the purpose of establishing a laboratory for the investigation of cancer. Most important of all, however, is the bill recently introduced in congress by Senator Owen providing for the organization of all of these activities of the government into a department of public health.

The general government might well afford to spend a relatively much larger portion of its income upon those scientific investigations that have for their purpose not only the elimination of unhealthful conditions and the protection of our nation from the dangers of impure food supplies, but also the development of preventive medicine. We are in these times quite as much interested in the prevention as in the cure of disease, and it is a sad commentary upon us as a nation that 72 per cent. of our national income is being spent in preparations for war and because of past wars, leaving only 28 per cent. available to meet all other expenses of the government. The average annual expenditure upon the army and navy for the past eight years, that is, since the close of the Spanish war, is sufficient to establish a three million dollar Rockefeller Institute in every state and territory of the union and still leave more than the amount of the present magnificent endowment of Pasteur Institute of Paris. Many of the state governments are likewise spending an abnormally large proportion of their revenues upon the non-productive classes. About 40 per cent. of the revenues of Illinois is being spent in caring for those who are either morally, mentally or physically incapable of the full responsibilities of citizenship in a free and democratic commonwealth. Illinois is no exception in this respect. It is a noble and a necessary work to provide for these non-productive classes in the state and in the community, but as I have said, we are to-day quite as much interested in the prevention as in the cure of disease, and doubtless no small portion of our non-productive classes are such be-

[2] Recently increased by an additional gift of $3,820,000.

cause of a diseased condition of mind or body which might have been avoided if they or their parents had better understood the principles of correct living. In order to promote the best interests of the state and to increase the efficiency of our productive classes, as well as to prevent in the future a further increase in the non-productive elements of our people, it is desirable to establish in this state, and in every state alongside of our agricultural experiment stations and our engineering experiment stations a great experiment station of sanitary sciences and preventive medicine. Such an experiment station should undertake to supplement the work now being done by our state and municipal boards of health. The principal function of these boards is to prevent by advice and by process of law the spread of contagious diseases and to supervise in a general way the sanitary conditions under which we live. This is valuable and important work, but it is not sufficient. We should have a body of trained investigators whose sole purpose should be to study in the light of biological science the data thus being collected from the various communities of the state and to supplement the same by special investigations whenever found necessary, to the end that there should be brought to bear upon the cause and prevention of unhealthful conditions all the results which scientific investigation can give. The long list of accomplishments of such institutes as have already been mentioned furnish abundant evidence of the value and importance of such research. Suppose, for example, such investigation should result in a discovery comparable to Behring's discovery of the treatment of diphtheria by antitoxic serum—a result by which in the last twelve years the mortality from this disease has been reduced to one fifth of its former rate. Contemplate for a moment the benefits which would come to the human race from a discovery of a means of preventing or curing pneumonia, an infection from which, I am told, as many die to-day as did a hundred years ago in spite of all the work which had been done upon it; or what a boon it would be to humanity if the cancer should be brought under control as have been smallpox and hydrophobia.

Such an experiment station should include a laboratory of physiological chemistry in which questions of human nutrition and problems growing out of it should be investigated—work not unlike that now being done by Professor Chittenden at New Haven, or that which was done by Professor Atwater at Middletown, and that which is now being carried on at the University of Illinois under the direction of a national commission of physiologists. It should include a bacteriological laboratory, fully equipped to carry on extensive investigation in the various branches of this comparatively new science and particularly to study its applications to the cause and prevention of diseases. Such an experiment station should be equipped with a laboratory of sanitary science in which the problems arising from water supplies, sewage disposal, sanitation and the relation of all of these to public health should be fully investigated. And finally there should be included a department of medical research, not that it should teach this or that system of medical practise, or be primarily a teaching body at all, but that it should undertake the investigation of the cause and prevention, as well as of the cure, of such diseases as have as yet not yielded to medical treatment.

Equally important, and that quite apart from the provision for scientific research upon problems of public health, is the provision we should make to educate the gen-

eral public as to the sources of danger, and the importance of protecting the community from the carelessness of the ignorant few. The results of scientific research are of no great consequence without that public sentiment which insures the application of these results for the benefit and the protection of all. In spite of the fact that science has long since determined the cause and the means of preventing the spread of the bubonic plague, it still rages in India simply because the great masses of the people of that country choose to regulate their personal habits in matters of cleanliness and sanitation according to the rules of the Brahmanistic religion rather than in accordance with the results of modern science. Ten thousand people in Chicago are to-day suffering from tuberculosis, pauperizing that city, as Commissioner Evans declares, to the extent of more than $20,000,000 a year, not so much because science has failed to suggest means of improvement as because of the ignorance of those afflicted and the lack of sufficient public sentiment to enable the authorities to compel property owners to provide the proper sanitary conditions.

What is needed most in the public health movement is an intelligent appreciation on the part of the leading citizens of our various communities of the necessity of suitable legislation and the proper enforcement of sanitary conditions. Montreal's recent experience with a smallpox epidemic illustrates the sad consequence from ill advice at a critical time. Due largely to the influence of a physician who had gone wrong scientifically a general sentiment against vaccination had developed and when a Pullman porter carried the disease to that city a general epidemic resulted, causing the death within ten months of 3,164 persons, most of whom were children under ten years of age. Contrast with this record that of Chicago for last year. Here in a city with ten times the total population of Montreal and with every opportunity for importing the disease through its great avenues of passenger traffic and its transient population, under the influence of public pressure better conditions prevailed. Thirty thousand deaths occurred last year in Chicago, but not a single death from smallpox, although numerous instances occurred where people coming to the city brought the disease with them.

Chicago, by the way, presents a good illustration of what a thoroughly scientific and efficient leadership can accomplish in protecting a community from unhealthful conditions. In 1891 that city had the largest death rate from typhoid fever of any city in the civilized world. To-day with its better facilities for the disposal of sewage, better inspection and protection of its water and food supplies, it is comparable in this regard with any other large center of population in this or any other country. In fact, Chicago now has the lowest death rate of any American city of more than 350,000 inhabitants. It is no small problem to undertake the inspection of the food supplies of a great city. For example, the milk supply of Chicago comes from four states and not unfrequently it is shipped a distance of more than fifty miles. It takes more than 240,000 gallons of milk a day to supply the city and this supply is produced upon 12,000 different farms and by more than 120,000 different cows. Yet in this great metropolis, the city ordinances provide for a careful inspection of the various food supplies; for example, no meat may now be offered for sale in the local markets of that city until it has received the stamp of approval of a city or government inspector. The advance made by Chicago within the last few years is due in a very large measure to the untiring

energy and the efficient leadership of Commissioner Evans and his colleagues.

As I have already remarked, what we need in every community is an intelligent and efficient leadership in this as in other matters of public concern. This need necessitates not only a training that will give us the few high-grade specialists who shall become our public health officers, but a training which may well be regarded as an essential element in the education of every man and woman who is to occupy a place of influence in the councils of the community and of the nation. Where shall we look for such training if not to our colleges. There should be in every college course required work of the character indicated and every college should have its department devoted to instruction in matters of sanitation and preventive medicine, not as an annex to some other already overcrowded department, but as a separate department with its full quota of instructors and provided with suitable laboratories. It may be of interest in this connection to observe that within the past two years great interest has been manifested not only by our leading medical schools, but by our colleges of liberal arts in extending their offerings in this line. Cornell is perhaps the best illustration of what can be accomplished in a popular way. Last year, the members of the faculty of that institution, in cooperation with the New York State Board of Health, conducted a course of lectures, extending throughout the year, upon the general problems relating to public health. The course proved to be very popular with the student body and was so largely attended both by the students and the citizens that at times standing room in the auditorium was at a premium. Similar courses have been either introduced or are now under discussion at several of the other leading institutions of the country. So far as I know, no institution has yet established a department of public health and preventive medicine. It is a development, however, that is bound to come in the immediate future and it is only a question as to what institution shall claim the honor of priority.

By way of conclusion, may I once more emphasize the important rôle that the sciences have played in our national progress and in the trend of our educational institutions, reflecting as these institutions do, not only the demands of a progressive people, but the requirements of an expanding and unfolding future.

Above all, the chief purpose of science is service, whether that service be in the development of the national resources of a country or in aiding the growth and expansion of its industries and of its commercial power; or whether it be in the conservation of those resources that constitute the inherited wealth of a people. In the great contest of nations, matching the efficiency of one people against that of another, no service is more important than that which science has rendered and is still to render in the preservation and protection of human life against the inroads of unnecessary and preventable disease. May you as students and teachers of the biological sciences, devoted as you are and should be to the development of these sciences in their broadest aspects, and all of us as citizens of a country that never hesitates to provide generously for those things that are for the general good and that contribute to national prosperity and success, lend a helping hand, to the end that our educational institutions and our country may stand foremost among those institutions and those nations contributing most to the great service which this generation shall render to the general progress of mankind.

E. J. TOWNSEND
UNIVERSITY OF ILLINOIS